

APPENDIX B

PRINCIPAL HAZARDOUS ACTIVITY EVALUATION SUMMARY

Table B-1 outlines the principal hazardous activities conducted at PGDP between 1952 and 1990. This table provides an assessment of the hazards

encountered by these activities, the controls used to mitigate the hazards, and the effectiveness of the controls. Acronyms are defined at the end of the table.

Table B-1. Paducah Gaseous Diffusion Plant Principal Hazardous Activity Evaluation Summary: 1952-1990

Description	Plant Location	Hazards	Controls	Effectiveness	Time Period
Ash handling (or hot hauling)	C-410, C-746B, C-400	RAD, exposure to UF ₆ gas, and inhalation of dust containing uranium and concentrated daughter products, fission products, and transuranics	PPE, worker rotation, film badges or TLD, stay times, bioassay program, ambient air flow	Moderately effective when used correctly	1952-1964, 1968-1976
Baghouse filter cleaning and changes	All	Airborne UF ₆ , Uranium oxides, process dust, RAD	PPE, film badges or TLD, stay times, bioassay program, ambient air flow	Moderately effective when used correctly	1950s-1990
Building access	C-340	Green salt, black oxides on floors and other surfaces	PPE, housekeeping	Ineffective	1957-1977
Burial of pyrophoric uranium metal in landfills	C-749	Exposure to uranium metal	None	Ineffective	1952-1980s
Carpentry	Cooling Towers	Asbestos, arsenic, fungicides	PPE	Effective when used correctly	1952-1990
Crane operation	C-400, C-410 C-420, C-331 C-33, C-335 C-337, C-340	Process gas, heat stress	PPE	Effective when used correctly	1952-1990
Cylinder heel cleaning	C-400	RAD, exposure to UF ₆ gas, and inhalation of concentrated daughter products, fission products, and transuranics	PPE, film badges or TLD, stay times, bioassay program, ambient air flow	Moderately effective when used correctly	1952-1990
Deblading of compressor rotor and stator	C-400	Possible release of UF ₆ , HF, UO ₂ F ₂ , transuranics and uranium daughters to shop area	UF ₆ negative procedure, washing, and PPE	Moderately effective when used correctly	1975-1981, During CIP/ CUP

Description	Plant Location	Hazards	Controls	Effectiveness	Time Period
Derby breakout, roasting, cleaning, and sawing	C-340	Uranium metal, black oxides of uranium, unburned Mg, uranium bearing sludge from quench tank	PPE, use of downdraft table for cleaning; later modified for improved ventilation flow and control of dust, fire extinguishers; operators on urinalysis	Effectiveness could not be determined; operators may not have been properly monitored for lung burden of insoluble oxides	1957-1977
Disassembly of stuck shut G-17 cell block valves	C-720	Possible release of UF ₆ , HF, UO ₂ F ₂ , transuranics, and uranium daughters to shop area	PPE, UF ₆ negative procedure, disassembly procedure, shop evacuation	Moderately effective when used correctly	1952-1990
Drum crushing	C-746	RAD, UF ₄ , and inhalation of uranium dust	PPE	Respiratory protection was not used until Health Physics and Hygiene identified serious concerns with airborne radioactive material concentrations in September 1981	1980-1982
Drumming green salt	C-340	Green salt dust	PPE required in 1/8/57 when drumming	Effective when used correctly	1957-1977
Dumping uranium from vacuum collector to drums and returning uranium to process	C-410, C-420	RAD and inhalation of uranium dust	PPE, bioassay program, ambient air flow	Moderately effective when used correctly	1952-1964, 1968-1976
Electrical	All	Process gas, PCBs, solvents, U ₃ O ₈ , lead	PPE	Effective when used correctly	1950s-1990
Fabrication	C-720	Lead, solvents	PPE	Effective when used correctly	1950s-1990
Firing reduction vessels (bombs) to make derbies	C-340	Vessel exploded in 1962 due to Mg overload; lid fires, burnouts could release molten uranium	Fire protection system, design of bomb, specifications on mandrels for producing bomb liners, operators on urinalysis	Effective when used correctly	1957-1962, 1968-1977
Flange grinding	C-400, C-340, C-410, C-420	U ₃ O ₈ (yellowcake), HF	PPE	Moderately effective when used correctly	1950s-1990

Description	Plant Location	Hazards	Controls	Effectiveness	Time Period
Groundskeeping	All	RAD, PCBs, asbestos, arsenic, fungicides	No PPE	Ineffective	1952-1970s
Guard patrolling	All buildings	Airborne UF ₄ , uranium oxides, process dust, RAD, TCE, HF, process gas, lead	PPE, film badge, or TLD	Minimally effective; PPE was generally used only during emergency situations	1950s-1990
HF collection and transfer to C-410	C-340	Anhydrous HF, cryogenic fluids	Closed system for collection and condensation of HF from towers; face shield, rubber gloves, apron, and hood; area roped off and impermeable suit used when systems open	Moderately effective	1957-1977
Landfill operations	C-746 K, S & T(inert)	Asbestos and ash from coal fired plant, dust from contaminated building rubble	None; in early 1980s, added controls on asbestos and building rubble disposal	Ineffective	1950s-1980s
Lubrication	All	PCBs, solvents, process gas, U ₃ O ₈	PPE	Moderately effective when used correctly	1950s-1990
Machining	C-720	Lead, process gas, solvents, uranium, beryllium	PPE	Effective when used correctly	1952-1990
Maintenance on roof	C-340	Venting of HF and uranium to roof from reduction towers	None; roof access controls implemented in December 1973	Ineffective	1957-1977
Midnight negatives	C-331, C-333 C-335, C-337	Release of UF ₆ , HF, UO ₂ F ₂ , transuranics, and uranium daughters to environment	Procedures limited practice to only purging cells with <10 ppm UF ₆	Effective, but may have been ignored in some cases	Prior to April 1986
Mixing UF ₄ powder with Mg powder, loading into bomb	C-340	Airborne UF ₄ powder, Mg metal powder, dust	PPE, film badge or TLD, Building dust collection system; spark proof tools provided for work in the magnesium room; operators on urinalysis	Moderately effective when used correctly	1957-1962, 1967-1977
Neptunium recovery	C-400, C-710	High concentrations of neptunium-237 in process solution; potential internal dose from leaks	PPE	Moderately effective when used correctly; some air samples high	1958 to mid-1960s

Description	Plant Location	Hazards	Controls	Effectiveness	Time Period
Product withdrawal during normal operations	C-310	RAD, exposure to UF ₆ gas from positive pressure system leaks and cylinder change-outs	PPE, worker rotation, film badges or TLD, stay times, bioassay program, ambient air flow	Moderately effective when used correctly	1952-1990
Pulverizer operations and maintenance	C-400	RAD and inhalation of dust containing uranium and concentrated daughter products, fission products, thorium, and transuranics; including neptunium and plutonium	PPE, worker rotation, film badges or TLD, stay times, bioassay program, ambient air flow	Moderately effective when used correctly	1952-1964, 1968-1976
Release response	Process and support buildings; C-331, C-333 C-335, C-337 C-310, C-315 C-340, C-400 C-410, C-420	Inhalation of radioactive materials/skin contamination, chemical burns	PPE, ventilation	Effective when used correctly; ventilation systems were frequently inoperable	1952-1990
Removal of “000” compressor stub shaft	C-720	Possible release of UF ₆ , HF, UO ₂ F ₂ , transuranics, and uranium daughters to shop area	PPE, UF ₆ negative procedure, local area exhaust, and pit and shop evacuation	Moderately effective when used correctly	1952-1990
Removal of compressor seals	C-400, C-720	Possible release of UF ₆ , HF, UO ₂ F ₂ , transuranics, and uranium daughters to shop area	PPE, UF ₆ negative procedure, and shop evacuation	Moderately effective when used correctly	1952-1980s
Removal of converter shell internal fixtures	C-409	Possible release of UF ₆ , HF, UO ₂ F ₂ , transuranics, and uranium daughters to shop area	PPE, UF ₆ negative procedure, additional purge in cell and in shop, shop evacuation	Moderately effective when used correctly	1975–1981 During CIP/ CUP
Replacement of full UF ₆ cylinder valve	Outside C-400	Possible release of UF ₆ , HF, UO ₂ F ₂ , transuranics, and uranium daughters on repair team and into environment	PPE, repair procedure, cooling cylinder to sub-atmospheric, and emergency response procedures	Effective	1952-1990
Slag recovery	C-340 Slag Plant	Uranium oxides and MgF ₂ dust	PPE, film badges	Not typically noted in operations instructions	1957-1977
Smelting	C-746	Airborne uranium, transuranics, process metals, RAD, HF, process gas	PPE, air samples, film badges or TLD, bioassay program	Moderately effective when used correctly	1950s-1990

Description	Plant Location	Hazards	Controls	Effectiveness	Time Period
Spraying cooling towers with fungicide	Cooling towers	Pentachlorophenol	PPE, procedures, and monitoring	Moderately effective when used correctly	1952-1990
Technetium recovery	C-400	High concentrations of technetium-99 in process solutions; potential skin and internal dose from leaks	PPE	Moderately effective when used correctly; no problems evident in bioassay results	1961-1963, 1970s
UF ₆ reduction to UF ₄	C-340 "Powder" Room (5 th and 6 th floors of the tower)	UF ₆ leakage, UF ₄ leakage, HF leakage, and airborne uranium	PPE, film badge or TLD, building dust collection system, operators on urinalysis	Moderately effective when used correctly	1957-1962, 1967-1977
Unplugging feed plant transfer lines, hoppers, and conveyers using sledge hammers and rods during normal operation	C-410, C-420	RAD, inhalation of uranium dust, noise	PPE, bioassay program, ambient air flow	Moderately effective when used correctly	1952-1964, 1968-1976
Unplugging fluorination towers	C-410	RAD, exposure to UF ₆ gas, and inhalation of dust containing uranium and concentrated daughter products, fission products, and transuranics	PPE, film badges or TLD, stay times, bioassay program, ambient air flow	Moderately effective when used correctly	1952-1964, 1968-1976
Uranium powder conveyer, hopper, and other equipment maintenance and replacements	C-410, C-420	RAD and inhalation of uranium dust	PPE, bioassay program, ambient air flow	Moderately effective when used correctly	1952-1964, 1968-1976
Uranium recovery (by solvent extraction)	C-400	Concentration of technetium-99; transuranics and uranium daughters provided potential radiation exposure and radioactive effluents	Rubber gloves and respirators available; effluents were sampled and release limits were applied	Moderately effective when used correctly; little guidance or direction on use of respirators; PPE worn at discretion of operator	1950s to mid-1970s
Welding	C-410, C-411, C-420, C-600, C-720, and all process buildings	Heat stress, acids, process gas, asbestos, HF, thermal burns	PPE	Effective when used correctly	1950s-1980s

Key:

CIP	Cascade Improvement Program
CUP	Cascade Upgrading Program
HF	Hydrogen Fluoride
PCB	Polychlorinated Biphenyl
PPE	Personal Protective Equipment (includes one or more of: respirator, shoes, ear plugs, and anti-contamination clothing)

RAD	Includes one or more of alpha, beta, or gamma radiation
TCE	Trichloroethene
TLD	Thermoluminescent Dosimeter

Abbreviations Used in This Report

AEC	Atomic Energy Commission
ACGIH	American Conference of Governmental Industrial Hygienists
ALARA	As Low As Reasonably Achievable
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CIP/CUP	Cascade Improvement Program/Cascade Upgrading Program
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
EPA	Environmental Protection Agency
ERDA	Energy Research and Development Administration
ES&H	Environment, Safety, and Health
HF	Hydrogen fluoride or hydrofluoric acid
IVRML	In Vivo Radiation Monitoring Laboratory
JHA	Job Hazard Analysis
KOW	Kentucky Ordnance Works
KPDES	Kentucky Pollutant Discharge Elimination System
MAC	Maximum Allowable Concentration
MPC	Maximum Permissible Concentration
MTM	Material Terminal Management
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
OR	Oak Ridge Operations Office
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Administration
PCB	Polychlorinated biphenyl
PCP	Pentachlorophenol
PGDP	Paducah Gaseous Diffusion Plant
PPE	Personal Protective Equipment
ppm	parts per million
PSO	Paducah Site Office
RCRA	Resource Conservation and Recovery Act
RCG	Radiation Control Guide
SPP	Standard Practice Procedure
SWMU	Solid Waste Management Unit
TCE	Trichloroethene
TLV	Threshold Limit Value
TSCA	Toxic Substances Control Act
USEC	United States Enrichment Corporation